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COMPARATIVE STUDY OF THE ANALYSIS AND DESIGN OF BOWSTRING GIRDER AND SEMI THROUGH PLATE GIRDER SUPERSTRUCTURE

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ABSTRACT

The bridge construction activity is as old as human civilization. In design of any kind of structure, economy is the essential criteria. In past plate girder bridge had being used but plate is available in limited length therefore splicing is required and also to improve buckling strength of the web intermediate and edge stiffener are required, they are expensive and transportation and handling of plate is difficult, while if we talk about truss bridge than it have open web girder so it resist low wind force and also transportation and handling of member is easy than plate girder.In the present study, we analyze bowstring and semi through bridge for same section and design for the same load. The goal of the study is to determine most favorable option from above two.The decisions based on the obvious element of engineering that are safety, serviceability, and economy. Following this aspect, a design for both bowstring and semi through Girder has been performed. After calculation two basics material consumption steel and concrete the most economical has been selected.

KEYWORDS: STAAD Pro., Bowstring Girder, Semi Through Girder.

1. INTRODUCTION

The bridge is life line of road network, both in urban and rural areas. With rapid technology growth, the conventional bridge has been replaced by innovative cost effective structural system.

In this study, the two-lane bridge is considered for analysis and design. In present study to make cost comparison, we consider the same span of 50m for both the bridges. The width of carriage way is taken as 12.0 m. On both the sides of the deck, The crash barrier is of size 0.45 m width and 0.9 m height and kerb are of size 0.25 m width and 0.150m height consider on above steel railing is considered. Deck slab thickness is 0.25 m and wearing coats thickness of 0.065 m are considered. In this study two-lane bridge considers so for two-lane bridge class 70R and class A vehicles are considered for analysis purpose as per IRC 6-2014

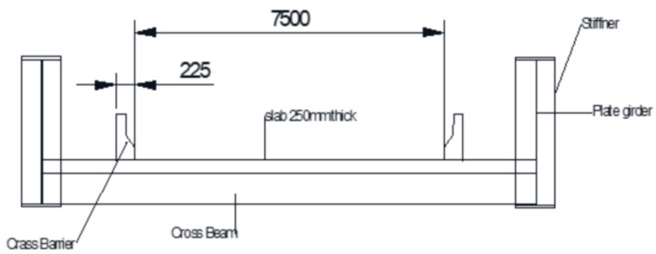

Fig.1 Cross Section Of Semi through Plate Girder

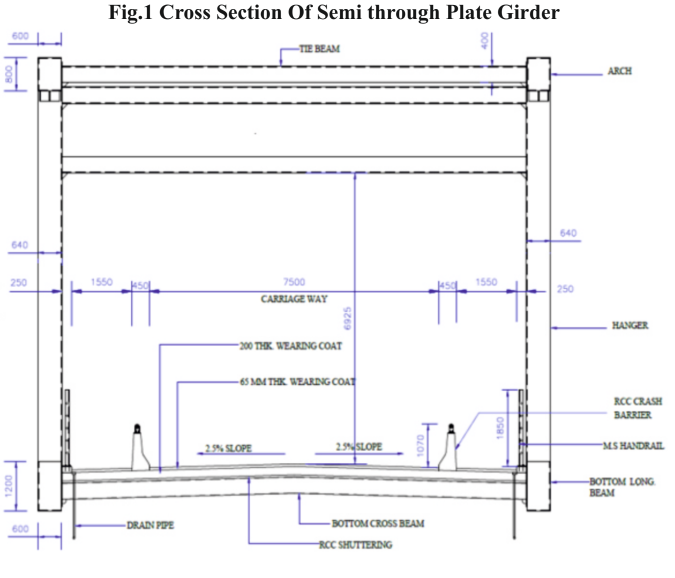

Fig.2 Cross Section Of Bowstring Girder

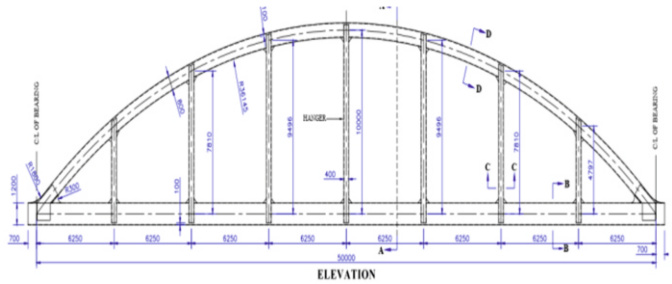

Fig 3. Elevation Of Bowstring Girder

2. MODELLING AND ANALYSIS

In present work, the bowstring girder superstructure is modeled in FEM based STAAD Pro. software. For preliminary analysis railway standard section adopted as shown in fig.2 and design carried out manually while for same loading semi through plate girder bridge designed manually. Detail design of Bridge Superstructure for Dead, live, seismic and wind load has been performed.

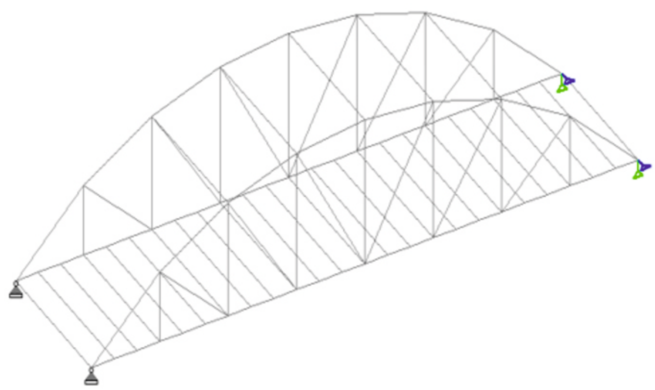

Fig 4. 3D View Of Bowstring Girder

Load Calculation: Bridges are designed for the different load as below.

1) **Dead load:** Dead load is the weight of the structure itself together with the permanent loads carried thereon

   In this study, dead load of 250mm slab, super imposed load of 65mm wearing coat and weight of kerb and crash barrier considered

2) **Live load:** live load is considered as per IRC-6:2014

For two-lane bridge IRC suggest two vehicle of Class –A and one vehicle of class-70R

3) **Wind Load:** A bridge considered 10m above the ground and 10 m height of bridge so structural design for total 20m height, For that Wind load calculated as per IRC-6:2014

IRC give wind load definition for different height for 33m/s wind speed, from that we interpolated for any speed

4) Seismic Load:
Feq = Ah * (D.L + appropriate L.L)

Appropriate live load shall be taken 20% of L.L (clause 219.5.2)

Zone Factor: 0.36

Importance Factor: 1 (as per IRC 24 Cl-219.5.1.1 , Table-8)

Response Reduction Factor (RF) : 2 (as per IRC Cl-219.5.5 , Table- 9)

Sa/g = average response acceleration

For medium soil site Sa/g = 2.50 (Normal bridge according Note, IRC – 6,2014)

- Load Combination:

Load combinations have been done as per IRC 6 – 2014, Table 3.2, pg.77 There are four load case and thirteen load combination using static load cases

Basic combination
1) 1.35 DL + 1.5 LL

2) 1.35 DL +1.5 LL + 0.9 WL +X

3) 1.35 DL +1.5 LL + 0.9 WL -X

4) 1.35 DL +1.5 LL + 0.9 WL +Z

5) 1.35 DL +1.5 LL + 0.9 WL -Z

6) 1.35 DL + 1.5 EQ +X

7) 1.35 DL + 1.5 EQ -X

8) 1.35 DL + 1.5 EQ +Z

9) 1.35 DL + 1.5 EQ -Z

10) 1.35 DL + 1.5 WL +X

11) 1.35 DL + 1.5 WL -X

12) 1.35 DL + 1.5 WL +Z

13) 1.35 DL + 1.5 WL –Z

3. RESULT

Two structural system adopted has been detail estimated Steel and concrete quantity has been calculated as per design requirement and consider local SOR rates the cost has been consider.

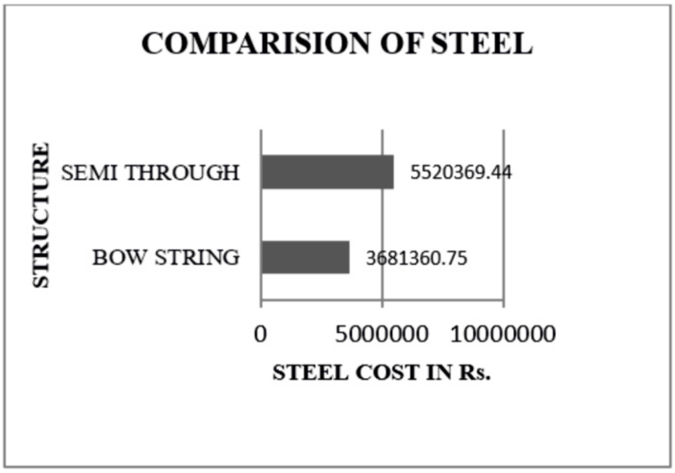

Fig. 5: Cost Comparison Of Steel Material

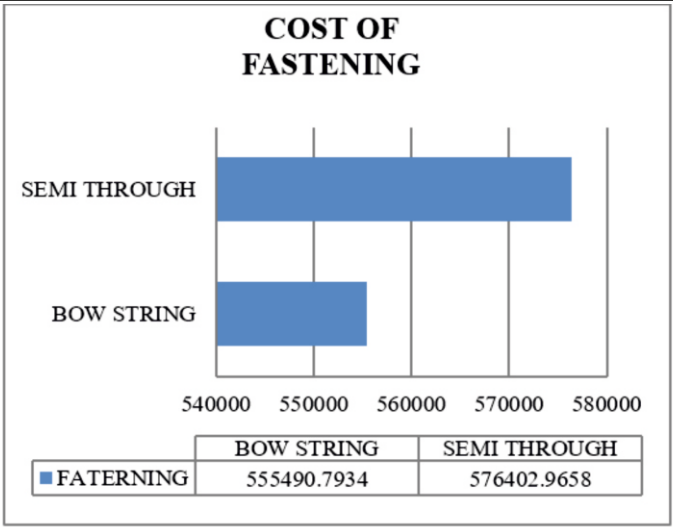

Fig. 6: Cost Of Fastening

Table 1: Estimation Of Total Cost

Structure	Cost Of Steel	Cost Of Fastening	cost of slab	Total (Rs.)
Bow String	3681360.76	555490.793	700382	4937233.55
Semi Through	5520369.45	576402.965	700382	6797154.41

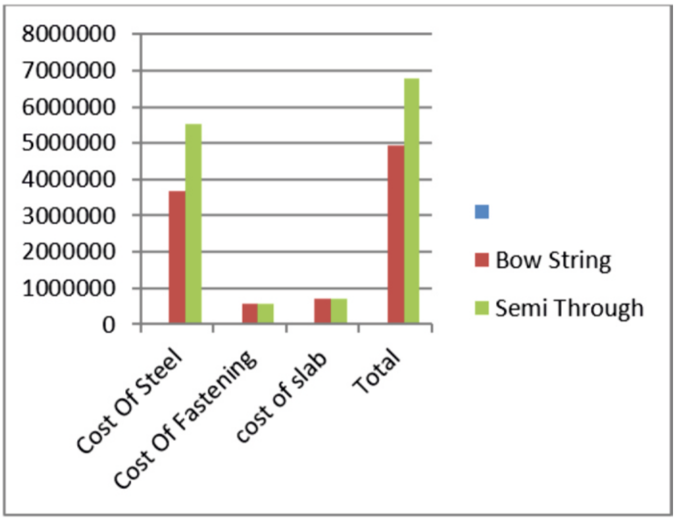

Fig.7: Comparison Of Total Cost

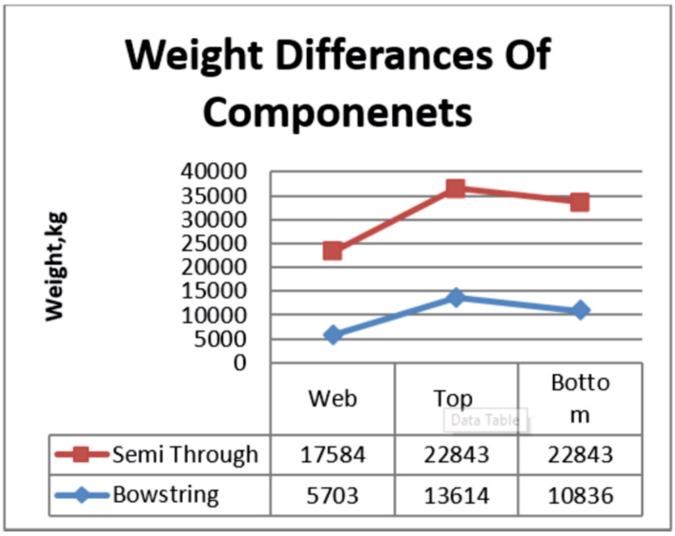

Fig 8. Weight Difference of components of superstructures

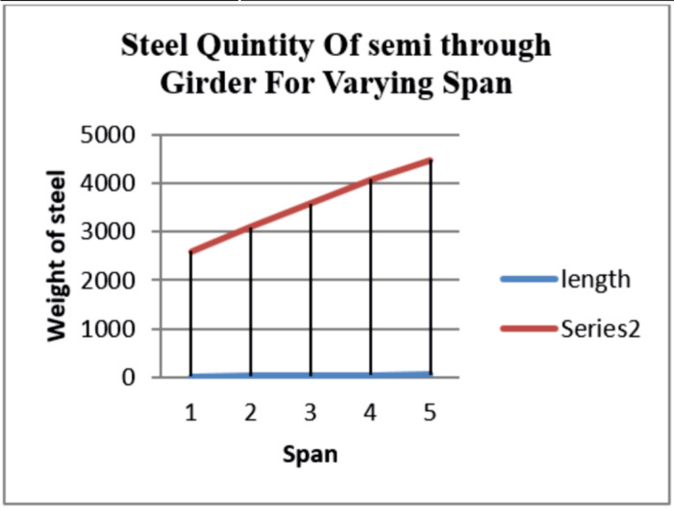

Fig 9. steel quantity of semi through girder for varying span per meter

4.CONCLUSIONS

The following conclusions are drawn upon:-

1. Service Dead load bending moments and Shear force for Bowstring girder bridge are lesser than semi through plate girder. Which allow the designer to have a lesser heavier section for Bowstring bridge than semi through plate girder for the 50m span.

2. Cost of structural steel for Bowstring girder bridge is less than semi through plate girder bridge, 20% saving of steel material saved by using bowstring bridge

3. Cost of Fastening for Bowstring girder bridge is less than semi through plate girder bridge, 2% saving in fastening of bowstring bridge compared to semi through plate girder bridge

4. Total cost of Bowstring bridge also less than semi through bridge, 18% of cost saving in bowstring bridge than semi through bridge

5. STAAD Pro. has played an important role in the whole study, quick geometry creation as well as accurate analysis and design of complex geometry in STAAD Pro. Is very good option

6. As shown from above Fig.8 we conclude that there is semi through plate girder web take more material than bowstring truss because of solid web, while truss girder has open web so 51% difference in quantity of web is obtained

7) Analytical study made for varying span of quantity of steel per meter for plate girder as in Fig.9, from that we clearly conclude that as increase of span cost is increased due to fastening and larger bending moments

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